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An investigation of the breeding-bird community within the Fort Lee Army Installation

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EXECUTIVE SUMMARY

Recent concern for the status of North American bird populations has resulted in an escalation of monitoring and management efforts. Much of this effort has been focused on declining species that migrate between breeding areas in North America and wintering areas in Latin America and the Caribbean. The U.S. Department of Defense (DOD) controls over 10 million hectares of land within the United States making it the third largest land holder in the federal government. Because of the high concentration of military installations within the mid-Atlantic region, DOD lands may represent the most promising opportunity to manage lands for populations of declining species. Through its partnership with the Partners in Flight initiative, DOD has committed to integrate neotropical migratory bird management efforts into existing natural resource management programs that are consistent with the military mission. This project was initiated to determine the status, distribution, and habitat associations of breeding birds on the Fort Lee Army installation so that they may be incorporated into existing resource management plans.

Breeding bird communities were sampled during the summers of 1997 and 1998 within a network of 52 habitat patches located on the Fort Lee Army installation. Patches were selected to represent the dominant habitat types found within the installation including urban, early successional, pine-dominated forest, mixed forest, and hardwood-dominated forest. A total of 86 species were detected during the study period. Species observed were categorized as residents (species that remain in the local area throughout the year), temperate migrants (those species that migrate between breeding and wintering grounds within North American latitudes), or

neotropical migrants (those species that migrate between breeding grounds in the temperate latitudes of North America and wintering grounds in Central and South America and the Caribbean). These three species groups accounted for 32.6%, 22.1%, and 45.3% of the species detected and 41.5%, 20.4%, and 38.1% of the individuals observed respectively. Observations of all three groups were dominated by a relatively small number of abundant species.

Habitats sampled were not equal in terms of the numbers and types of breeding birds supported. In general, forested patches supported more species and higher densities of birds. Bird communities within urban patches were dominated by resident species and to a lesser extent by temperate migrants. Many of the residents detected within urban patches were non-native species that are typically associated with human-dominated landscapes. Bird communities within early successional patches were dominated by temperate migrants with relatively equal contributions by residents and neotropical migrants. Forest bird communities were dominated by resident and neotropical migrants. Both bird density and diversity were influenced by forest composition. Forest patches with large amounts of hardwood supported the highest densities of birds. In comparison to the other two species groups, neotropical migrants exhibited the most dramatic response to habitat type. Density of neotropical migrants varied widely across the installation and was highest within hardwood-dominated forests surrouinding headwater streams.

INTRODUCTION

In recent years, concern for the status of many North American bird populations has greatly increased within both the general populous and the scientific community. Much of this concern has been focused on the many species of neotropical migrants (those species that migrate between breeding grounds in the temperate latitudes of North America and wintering grounds in Central and South America and the Caribbean) that have exhibited dramatic population declines in recent decades (sensu Hagan and Johnston 1992). In particular, a great deal of attention has been given to forest-dwelling neotropical migrants. This bird assemblage is very diverse, accounting for 65-85% of birds within the forest ecosystems of North America. Many of these species require interior forest areas and so are especially vulnerable to habitat fragmentation (e.g. Forman et al. 1976, Lynch and Whigham 1984, Blake and Karr 1987, Robbins et al. 1989). Growing evidence of declines in other species has extended these concerns to temperate migrants (those species that migrate between breeding and wintering grounds within North American latitudes) and non-migratory species (Askins 1993).

In some cases, suites of species that share ecological requirements have declined suggesting that habitat loss may be a contributing factor. In fact, the overall loss of breeding habitat has accompanied population declines in several communities. For example, results from the U.S. Fish and Wildlife Service Breeding Bird Survey indicate that nearly 75% of the species that specialize on early successional habitats such as grassland and shrubland have declined significantly over the last three decades. Widespread changes in farming have reverted vast land areas back to forest and resulted in the loss of open lands. In the New England area a loss of

60% of the early successional lands over the past 100 years has left many species threatened or endangered within the region (Vickery et al. 1994). Similarly, surveys of the bottomland hardwood forest in the Tensas watershed basin show that the number of breeding forest species and the population densities of forest interior species decreased with cumulative losses of forest area (Burdick et al. 1989).

Lands near continental coasts are experiencing some of the fastest development rates of any habitats within North America. Greater than 52% of the United States human population now lives within 80 km of U.S. coastlines (Southworth 1989). Between 1950 and 1986, the number of people living along the shores of the Chesapeake Bay and its lower tributaries increased by 50%. This population is projected to increase by at least 2.6 million or an additional 20% by the year 2020. Growth within the coastal zone will likely continue for the foreseeable future, placing increasing pressures on breeding habitats required by many bird species.

The U.S. Department of Defense (DOD) controls over 10 million hectares of land within the United States making it the third largest land holder in the federal government (Goodman 1996). Because of the high concentration of military installations within the mid-Atlantic region, DOD lands may represent the most promising opportunity to manage lands for populations of declining species. In 1991, DOD through each of the military services joined the Partners in Flight initiative. Through this partnership, DOD has committed to integrate neotropical migratory bird management efforts into existing natural resource and land management programs that are consistent with the military mission. However, before species may be incorporated into

existing management programs it is first necessary to identify habitat requirements so that management objectives may be developed.

This project was initiated to investigate the community of breeding birds utilizing Fort Lee and to determine their habitat associations and distribution. Information collected is intended to allow for the incorporation of neotropical migrants into resource management plans.

METHODOLOGY

Fort Lee

Field work was conducted on Fort Lee U.S. Army Installation in Prince George County Virginia. The installation is located within the outer portion of the Atlantic Coastal Plain. The site includes some 2,198 ha of land situated both north and south of Virginia route 36 between Petersburg and Hopewell. Land holdings south of rt 36 (main post hereafter referred to as "MP") contain approximately 1,670 ha while lands north of rt 36 (range training area hereafter referred to as "RTA") include approximately 528 ha.

Fort Lee lies within the urban crescent between Washington D.C. and Virginia Beach. The installation and surrounding lands are easily accessible by major transportation corridors including interstate 95, interstate 85, and the recently completed bypass route of interstate 295. Within the immediate area, historic plantations and agricultural lands are increasingly giving way to urban sprawl, expanding cities, and large industrial complexes. In the 30 years between 1960 and 1990, the human population within the surrounding counties (including Henrico, Chesterfield, and Prince George) and independent cities (including Petersburg, Colonial Heights, and Hopewell) has increased 95% from 273,038 to 532,101 (Forstall 1996). This growth is

expected to continue into the foreseeable future, increasing the relative role of installation lands in the conservation of natural resources on a regional scale.

The land constituting Fort Lee has variable topography and is drained by three river systems. The west portion of the RTA is a wide interfluv that has relatively little topographic relief and is poorly drained. The east side of the RTA forms the headwaters of Cabin Creek that flows north a short distance to the Appomattox River. The MP has greater topographic relief, particularly within the east central portion where it forms the headwaters of Bailey's Creek. Bailey's Creek flows northeast from the MP, eventually reaching the James River. The southern third of the MP is low, poorly drained, and forms the headwaters of the Blackwater River.

Currently, land cover at Fort Lee is a mix of open land, forested land, and developed land. Open habitats include grasslands that are managed under a relatively long mowing rotation such as the M16 Training Range, the McLaney Drop Zone, and many interstitial fields within the MP. Open habitats also include grasslands that are intensively managed under a relatively short mowing rotation such as Nowak Field, the golf course, and many other recreational fields. Forested lands span a gradient in composition from pine-dominated, to mixed, to hardwood-dominated forests. Forested lands also include a wide range of ages. Finally, developed lands include training areas, office complexes, warehouse facilities, dormitories, and residential areas.

Study Approach and Patch Selection

At the outset of this investigation, a number of information goals were outlined that were used to guide the selection of areas for data collection. The three most prominent considerations in this process were: 1) to provide coverage that would reflect the full range of habitats available on the installation, 2) to provide information on a scale that would be useful for land

management, and 3) to provide information that would be consistent with recent forest inventory data.

Examination of the lands within the borders of the Fort Lee installation lead to the development of 3 major habitat categories including: 1) Urban, 2) early successional, and 3) forest. Urban habitats were considered to include those areas that have been developed for regular human use and where man-made structures dominate the landscape. These patches include areas containing a variety of structures such as residential developments, office complexes, warehouse facilities, recreational areas, shopping areas, etc. Early successional habitats include open patches that fall within the gradient between grasslands and shrublands. These patches are similar to those that arise from "oldfield" succession (Johnston and Odum 1956). Within the installation, early successional patches include intensively managed grasslands used for military training, shrublands, and recent clearcuts. Forest land is the dominant habitat type found within the Fort Lee installation covering over 1,100 ha or approximately 50% of the total land area. All forest lands located within the installation have been delineated into compartments for the purpose of inventory and management (Mallette 1997). In order to make bird information most useful for forest management decisions, compartments were used as the basis for establishing the spatial structure of bird surveys.

A total of 47 forest compartments have been delineated within the Fort Lee installation (Mallette 1997). Forest compartments found within the installation vary in composition, age, and size (TABLE 1). The composition of forests varied from stands that were entirely comprised of pine to stands that were nearly all hardwoods. In order to examine the influence of forest composition on the breeding bird community, forest patches were subdivided into 3 categories

TABLE 1. Forest inventory statistics for patches used during breeding surveys. P-den and H-den refer to pine and hardwood stem densities presented in stems/ha. P/H refer to pine/hardwood ratios. Dashed lines indicate data not reported. Data modified from Mallette 1997.

		Saw Timber			Pole Timber				
Stand	**Age**	**P-den**	**H-den**	**P/H**	**P-den**	**H-den**	**P/H**	**Sap.**	**Shrub**
1	30-80	128.7	53.4	74.4	805.5	35.3	95.8	271.8	2538.9
2	24	128.5	0	100.0	---	---	---	679.5	1359.1
3	35	76.8	97.1	44.2	0	143.1	0	233.3	2223.9
4	100	27.9	61.0	36.3	70.7	273.3	20.5	271.8	3570.6
5	10	0	0	---	0	0	---	1029.7	6671.7
6	24	0	18.3	0	926.9	31.4	96.7	1070.7	543.6
7	15	18.8	0	100.0	207.8	403.3	34.0	593.0	3904.2
8	17	8.9	34.3	20.6	0	167.3	0	61.8	2841.7
9	25	23.2	0	100.0	0	70.7	0	555.9	10625.3
10	20	100.8	22.2	81.9	283.2	64.5	81.4	988.4	4293.3
11	87	104.0	41.2	71.6	0	564.4	0	0	803.1
12	25	68.0	21.0	76.4	260.2	218.9	54.3	864.9	3933.1
13	29	142.8	36.6	79.6	367.2	87.5	80.8	803.1	3243.2
14	60	150.5	51.1	74.6	16.6	167.3	9.0	300.0	1906.1
15	60	116.1	18.3	86.4	196.7	34.1	85.2	659.0	3747.5
16	28	77.3	0	100.0	1202.4	38.8	96.9	906.1	3130.0
17	84	12.6	90.7	12.2	0	337.3	0	370.7	2656.3
18	40-65	123.3	29.2	80.9	18.0	161.9	10.0	222.4	1495.0
19	75	83.8	19.5	81.1	89.7	55.8	61.6	247.1	5040.8
20	66	209.3	0	100.0	0	0	---	308.9	13034.5
21	86	144.8	1.7	98.8	0	0	---	308.9	5590.6
22	59	55.6	18.8	74.8	11.4	27.2	15.9	0	3582.9
23	94	101.6	105.3	49.1	9.1	278.0	3.2	49.4	1779.1
24	28	144.8	0	100.0	411.2	0	100.0	556.0	3212.3
25	25-70	119.3	56.3	67.9	63.8	85.0	42.9	481.8	2520.4
26	23	92.4	8.9	91.2	274.3	526.1	34.3	988.4	6733.5
27	27-80	105.5	37.1	74.0	122.6	144.3	45.9	617.8	3624.2
28	59	381.5	34.6	91.7	134.9	140.4	49.0	437.9	3257.0
29	32-54	80.6	117.6	40.6	41.0	135.9	23.2	262.7	1976.8
30	28	86.9	24.0	78.4	377.3	17.8	95.5	370.7	3848.6
31	71-85	29.4	91.7	24.3	0	30.1	0	123.6	2223.9
32	77	77.3	62.8	55.2	0	40.8	0	205.8	1935.5
33	50-75	41.3	92.9	30.8	64.0	80.6	44.3	345.9	2797.2
34	65	0	---	---	---	---	---	161.6	3221.7
35	65	109.7	56.1	66.2	0	112.2	0	234.7	2483.4
36	75-90	18.8	113.7	14.2	0	126.0	0	82.3	2965.2
37	55	144.8	112.2	56.3	0	51.6	0	144.1	1523.9

TABLE 1. --continued--

		Saw Timber			Pole Timber				
Stand	**Age**	**P-den**	**H-den**	**P/H**	**P-den**	**H-den**	**P/H**	**Sap.**	**Shrub**
38	65	139.4	0	100.0	0	6.2	0	247.1	2532.8
39	45	94.6	82.8	53.3	40.3	46.2	46.6	185.3	1389.9
40	28	187.3	0	100.0	1213.3	0	100.0	123.6	4386.0
41	65	4.4	187.1	2.3	0	44.7	0	123.6	1173.7
42	55	264.9	58.1	82.0	0	121.1	0	568.3	1210.8
43	17	0	0	---	67.5	0	100.0	1235.5	1112.0
44	28	187.5	2.7	98.6	650.4	16.3	97.6	329.4	3994.6
45	35-65	5.7	68.4	7.7	0	357.6	0	370.7	1915.0
46	60	44.0	116.6	27.4	7.2	219.9	3.2	308.9	1210.8
47	22-50	121.6	0	100.0	415.9	125.8	76.8	803.1	3544.7

according to composition. Forest categories include: 1) pine-dominated forests, 2) mixed forests, and 3) hardwood-dominated forests. Forest statistics from recent inventories (Mallette 1997) were used to assign compartments to categories by using the ratio of pine stems to hardwood stems. For older forest patches, sawtimber ratios were used. For younger forest patches, poletimber ratios were used. Forest patches were considered to be pine-dominated if pine stem to hardwood stem ratios were > 70%, mixed if pine stem to hardwood stem ratios were 30-70%, and hardwood-dominated if pine stem to hardwood stem ratios were < 30% (TABLE 1). Due to the lack of variation within the installation in both stand age (nearly 60% of patches were > 40 years old and more than 90% of patches were > 20 years old) and patch size these were could not be evaluated as independent factors.

A total of 52 habitat patches were surveyed for breeding birds during the course of the study period. These included 4 urban patches, 4 early successional patches, 28 pine-dominated forest patches, 8 mixed forest patches, and 8 hardwood-dominated forest patches (see TABLE 2 for descriptive statistics and list of habitat patches and FIGURE 1a and 1b for a map of habitat patches). One forest patch was not surveyed because it had been cleared for the construction of new housing (compartment 32) and another was not surveyed due to the high frequency of military maneuvers (compartment 47).

Bird Survey Technique

Between 1 and 8 survey plots were established within each habitat patch depending on patch size (TABLE 2). To set up study patches, scale maps were first generated by tracing the outline of habitat patches from compartment maps or from 1:24000 scale aerial photographs (FIGURE 2). Patch maps were then used to determine the most effective configuration of survey

TABLE 2: Description of habitat patches surveyed for breeding birds. See text for criteria used for delineation of forest types.

Patch Code	Patch Type	Patch Area (ha)	# Survey Points
1	Pine-dominated Forest	107.8	8
2	Pine-dominated Forest	3.2	1
3	Mixed Forest	35.6	4
4	Mixed Forest	61.4	4
5	Pine-dominated Forest	10.6	2
6	Pine-dominated Forest	20.2	4
7	Pine-dominated Forest	31.2	4
8	Hardwood-dominated Forest	4.3	2
9	Pine-dominated Forest	3.1	2
10	Pine-dominated Forest	17.6	4
11	Pine-dominated Forest	4.5	2
12	Pine-dominated Forest	39.6	4
13	Pine-dominated Forest	21.9	4
14	Pine-dominated Forest	41.8	4
15	Pine-dominated Forest	11.0	2
16	Pine-dominated Forest	10.1	2
17	Hardwood-dominated Forest	3.4	2
18	Pine-dominated Forest	43.3	4
19	Pine-dominated Forest	24.2	3
20	Pine-dominated Forest	13.2	2
21	Pine-dominated Forest	15.0	4
22	Pine-dominated Forest	6.3	2
23	Mixed Forest	19.0	2
24	Pine-dominated Forest	3.7	2
25	Mixed Forest	41.4	5
26	Pine-dominated Forest	5.1	4
27	Pine-dominated Forest	23.1	1
28	Pine-dominated Forest	45.5	4
29	Mixed Forest	30.5	4
30	Pine-dominated Forest	16.0	1
31	Hardwood-dominated Forest	26.8	3
33	Hardwood-dominated Forest	102.9	4
34	Hardwood-dominated Forest	50.9	4
35	Mixed Forest	39.5	4
37	Mixed Forest	22.6	4
38	Pine-dominated Forest	4.5	2
39	Mixed Forest	18.1	3
40	Pine-dominated Forest	2.5	1
41	Hardwood-dominated Forest	15.4	2

TABLE 2: --continued--

Patch Code	Patch Type	Patch Area (ha)	# Survey Points
42	Pine-dominated Forest	19.5	2
43	Pine-dominated Forest	3.6	1
44	Pine-dominated Forest	11.1	4
45	Hardwood-dominated Forest	17.6	4
46	Hardwood-dominated Forest	44.4	4
50	Early Successioinal	23.3	4
51	Early Successioinal	22.9	5
52	Early Successioinal	23.5	4
53	Early Successioinal	63.7	5
54	Urban	126.3	4
55	Urban	86.7	4
56	Urban	55.1	4
57	Urban	77.0	4

FIGURE 1. Map of Main Post a) and Range Training Area b) illustrating the boundaries of habitat patches (outlined in red). Patch numbers correspond to TABLE 1 and TABLE 2. Both maps are modified from Mallette 1997.

Map of Habitat Patches
(Fort Lee Main Post)

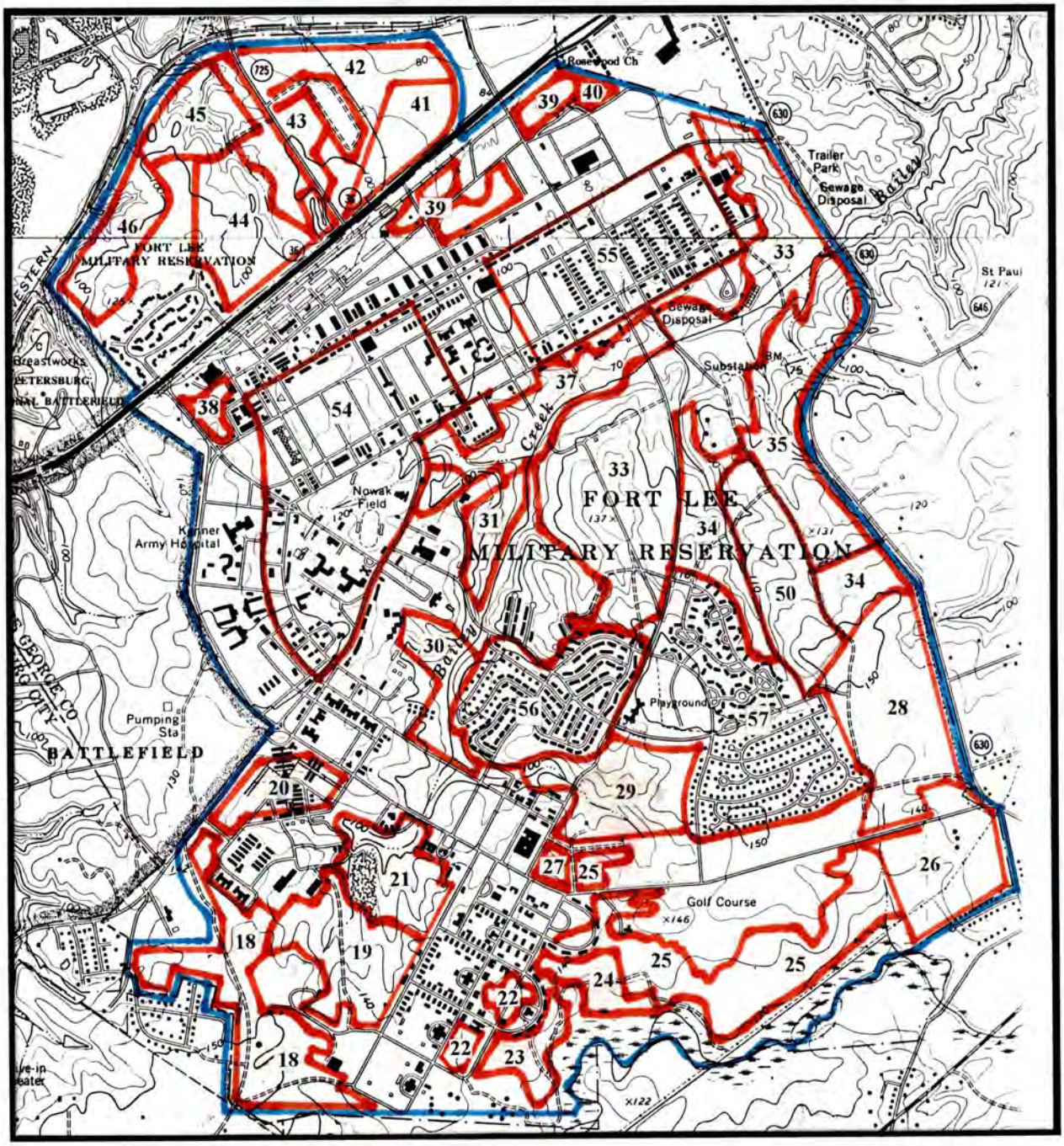


Figure 1A

Map of Habitat Patches
(Fort Lee Range Training Area)

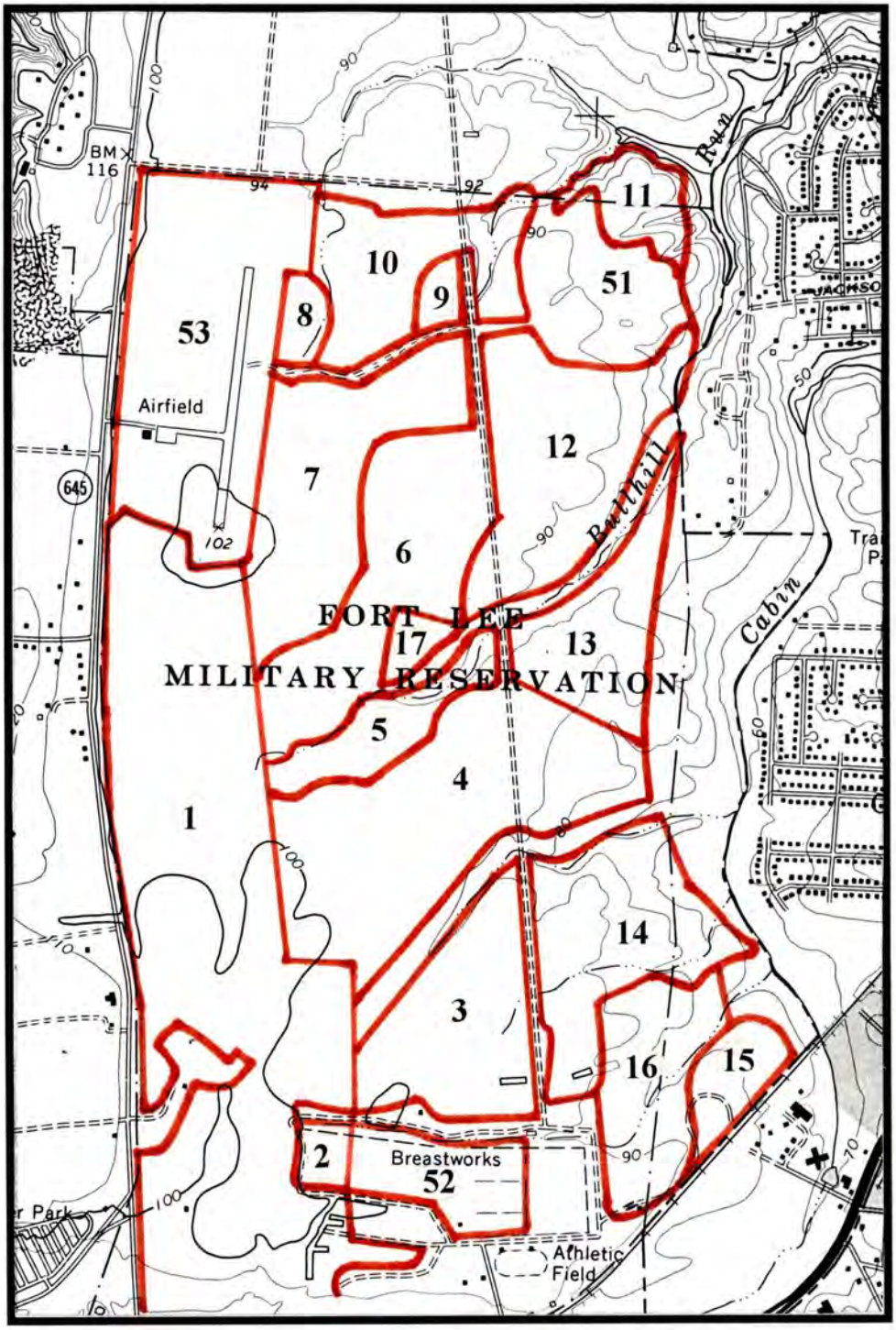


Figure 1B

FIGURE 2. Sample patch map used to lay out survey points.

Example Patch Map

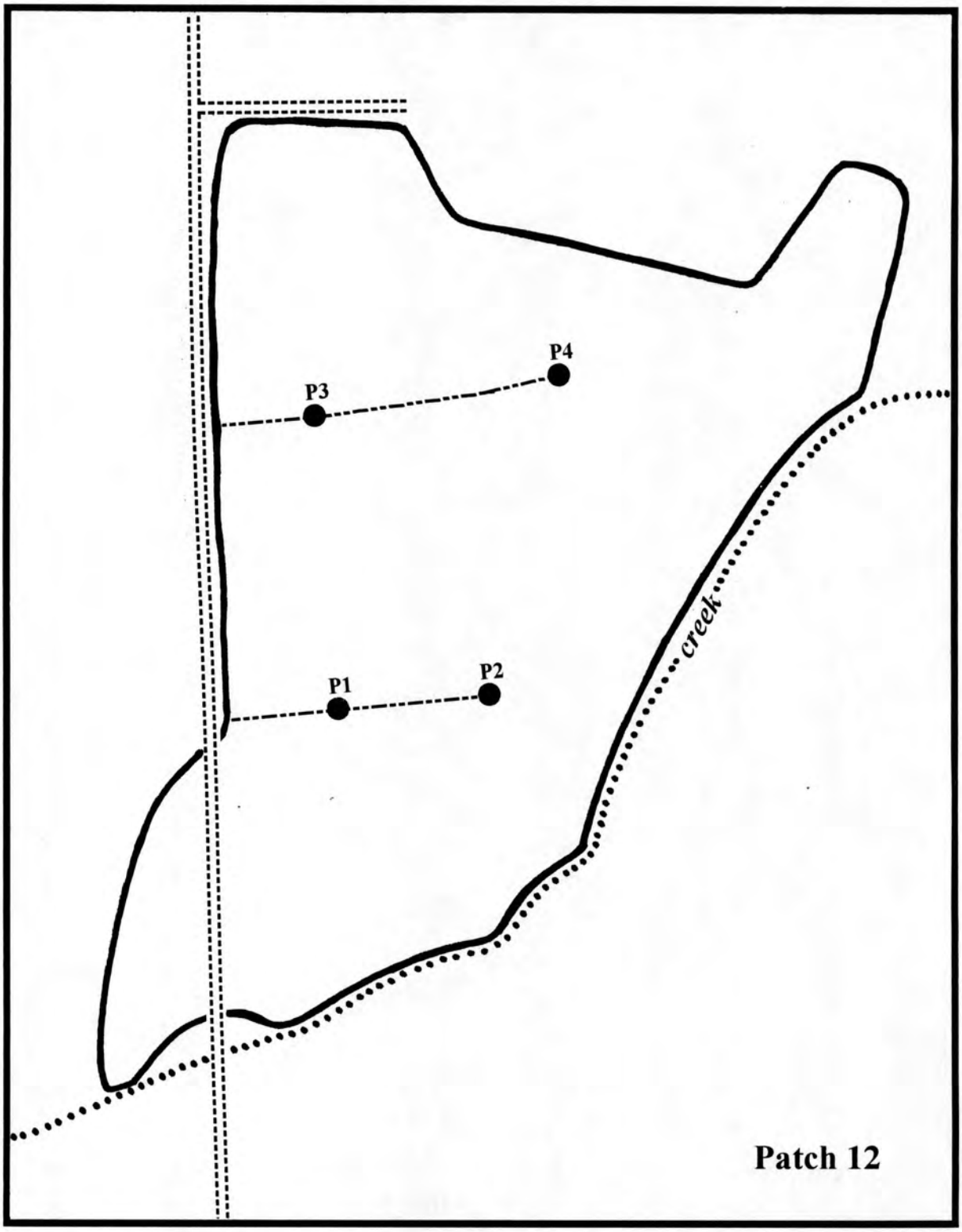


Figure 2

plots. Survey patches were laid out by marking trails with flagging tape and marking plot centers with wire flags or tape. Adjacent survey plots were separated by a minimum of 150 m.

A fixed-radius point count technique was used to measure bird density and frequency of occurrence. Survey plots (point counts) consisted of a 50 m radius circle. An observer stood at the center of the plot and recorded all birds seen or heard within the stand for a period of 5 min. Birds detected within stands were recorded as either within or outside the 50 m radius.

Bird surveys were conducted between 9 June and 26 June 1997, and 4 June and 30 June 1998. Each habitat patch was surveyed three times during the course of the study. This included once during the 1997 breeding season and twice during the 1998 breeding season. All surveys were conducted by three observers. Surveys were initiated 0.5 hr after sunrise and concluded by 10:00 EST. No independent attempt was made to survey nocturnal species.

Data Summary

Detection frequencies were calculated for all species at the patch level. Birds were considered to have occurred within a given patch if they were detected (inside or outside of the survey plots) during any survey. Detection information was used to compile species richness values for each habitat patch. Species richness was calculated separately for each bird category. Mean richness values were then generated using habitat patches as statistical units. Bird densities were also calculated at the stand level by dividing the highest combined count (including all survey points within a given patch) for each species by the combined area of the survey plots. Density values are presented in birds/10 ha. Combined bird densities were also calculated for each bird category. Mean densities were compared between habitats using patches as statistical units.

RESULTS

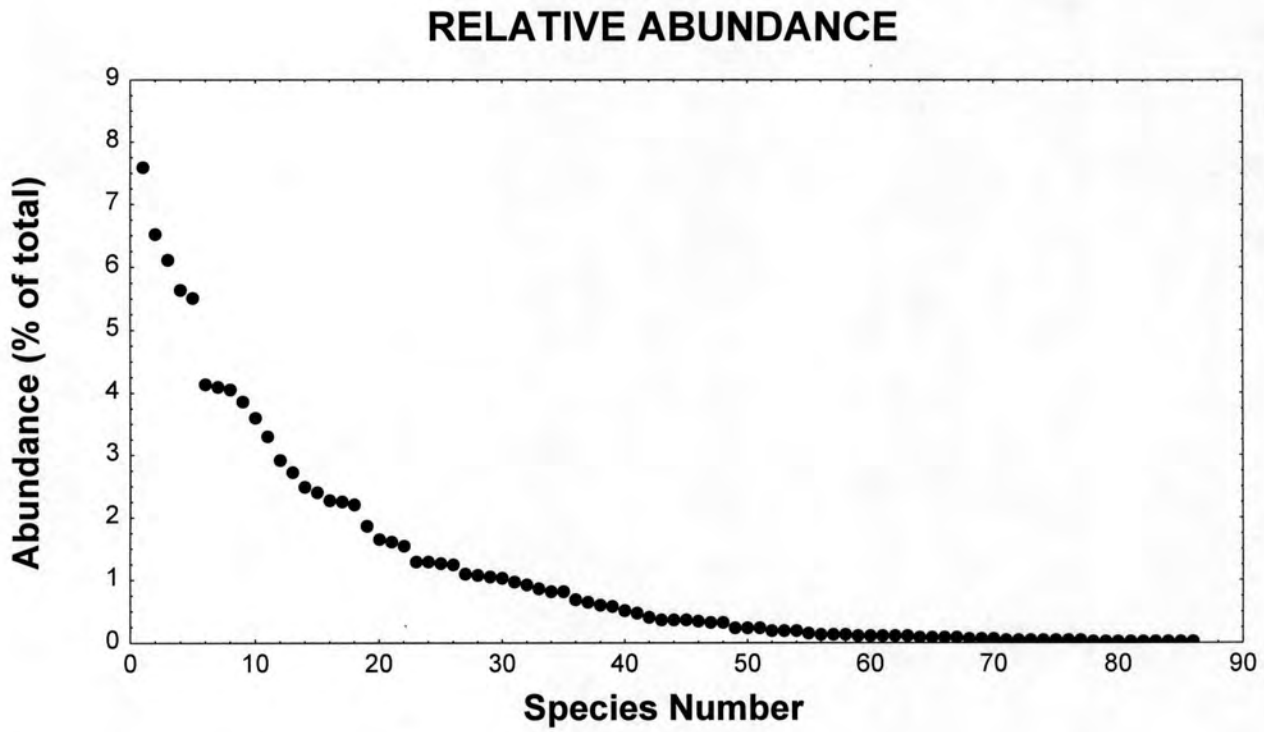
General

A total of 4,668 observations of 86 bird species were made during the study period (full species list with associated scientific names are given in APPENDIX 1). Species observed included 28 (32.6%) residents, 19 (22.1%) temperate migrants, and 39 (45.3%) neotropical migrants. Resident species accounted for 41.5% of individuals detected with temperate and neotropical migrants accounting for 20.4% and 38.1% of individuals respectively. Frequency of occurrence varied widely among species (FIGURE 3a). The result of this abundance pattern is that relatively few species accounted for the majority of observations (FIGURE 3b). For example, the top 10% of species accounted for more than 40% of the observations and the top 50% of species accounted for more than 96% of all observations.

Species Categories

As with the overall bird community, relative abundance varied widely between species within each of the migration categories (FIGURE 4). More than 90% of all observations of resident species were accounted for by only 13 species. Similar patterns were observed for temperate and neotropical migrants with only 9 and 14 species representing greater than 90% of respective observations. Observations of resident species were numerically dominated by the Tufted Titmouse, Carolina Chickadee, Northern Cardinal, and Carolina Wren. These species represent some of the most common residents within the region and were widely distributed within forest habitats throughout the installation. Temperate migrant species were dominated by the American Robin, Blue Jay, Eastern Towhee, and Common Grackle. Unlike residents, many of the dominant temperate migrants are species most often associated with early successional

FIGURE 3. a) Relative abundance of individual species arranged in descending order (N = 4,668). b) Species accumulation curve showing the relative contribution of individual species to the total observations.


RELATIVE ABUNDANCE
Abundance (% of total)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
Species Number

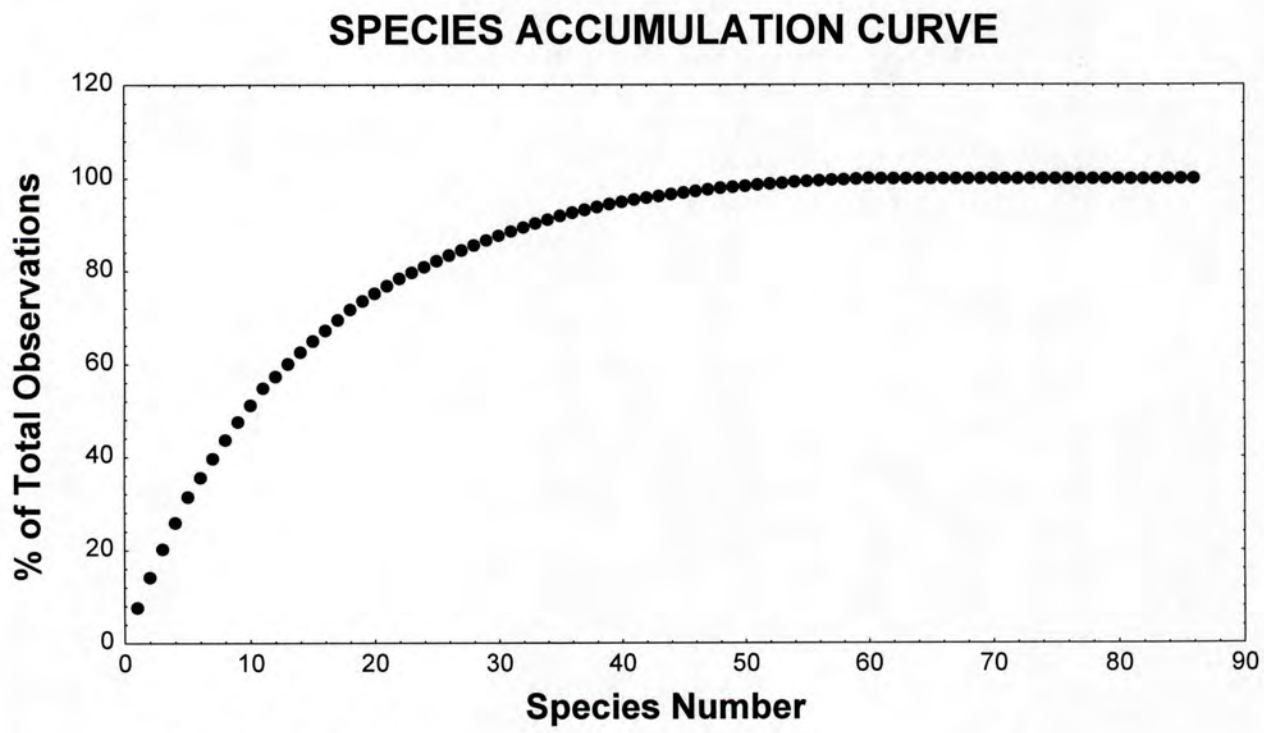

SPECIES ACCUMULATION CURVE
% of Total Observations
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
90
Species Number

FIGURE 3.

FIGURE 4. Relative abundance of common species within each species category. Alpha codes used in graphs are identified below.

Resident Speces		Temperate Migrants		Neotropical Migrants	
Code	**Species**	**Code**	**Species**	**Code**	**Species**
ETTI	Eastern Tufted Titmouse	AMRO	American Robin	REVI	Red-eyed Vireo
CACH	Carolina Chickadee	BLJA	Blue Jay	OVEN	Ovenbird
NOCA	Northern Cardinal	RSTO	Eastern Towhee	PIWA	Pine Warbler
CARW	Carolina Wren	COGR	Common Grackle	WOTH	Wood Thrush
EUST	European Starling	EAME	Eastern Meadowlark	ACFL	Acadian Flycatcher
AMCR	American Crow	GRSP	Grasshopper Sparrow	GCFL	Great-crested Flycatcher
RBWO	Red-bellied Woodpecker	FISP	Field Sparrow	SUTA	Summer Tanager
DOWO	Downy Woodpecker	RWBL	Red-winged Blackbird	EAPH	Eastern Phoebe
HOFI	House Finch	NOFL	Northern Flicker	EAWP	Eastern Wood Pewee
WBNU	White-breasted Nuthatch			BGGN	Blue-gray Gnatcatcher
BHCO	Brown-headed Cowbird			SCTA	Scarlet Tanager
MODO	Mourning Dove			INBU	Indigo Bunting
NOMO	Northern Mockingbird			YBCU	Yellow-billed Cuckoo
				COYE	Common Yellowthroat

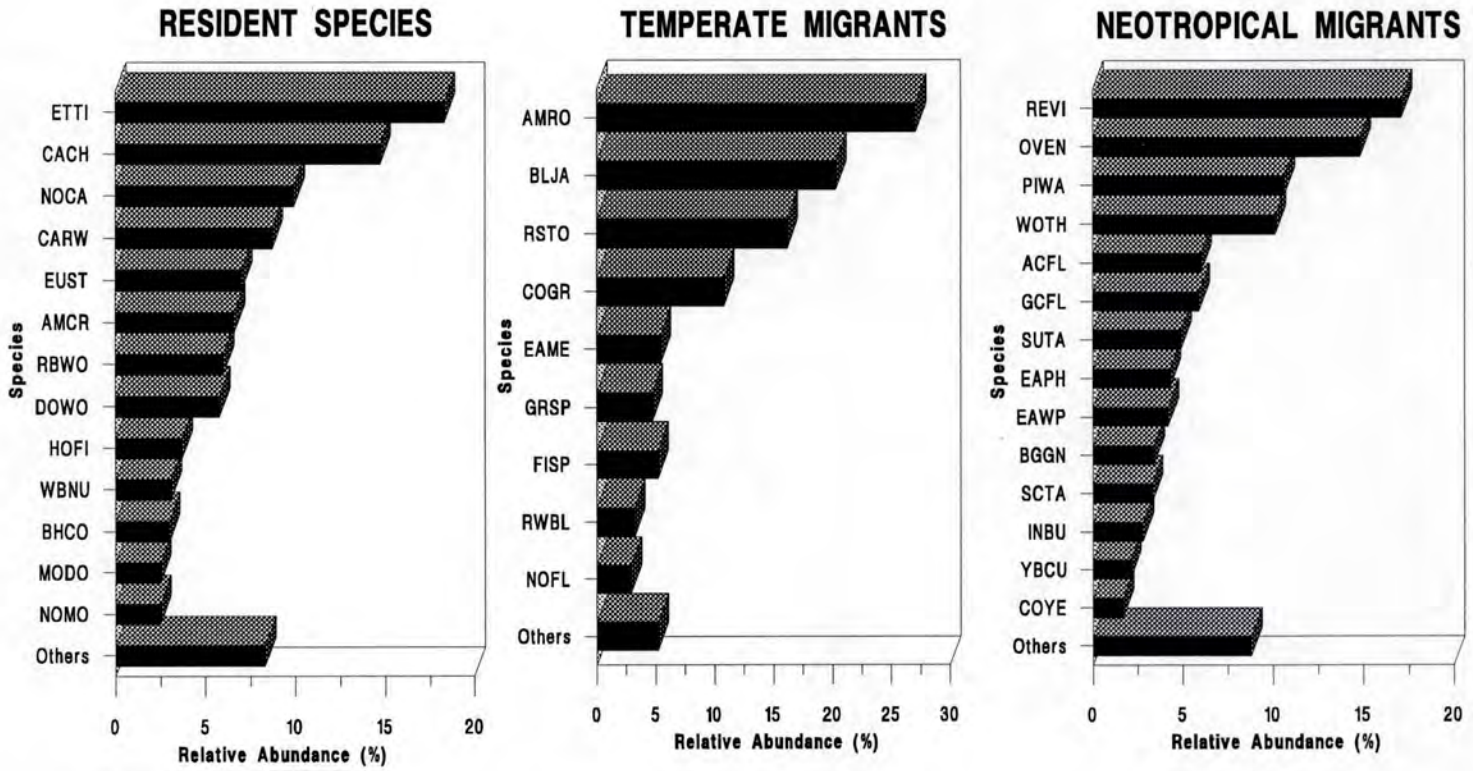

RESIDENT SPECIES
ETTI
CACH
NOCA
CARW
EUST
AMCR
RBWO
DOWO
HOFI
WBNU
BHCO
MODO
NOMO
Others
Species
0
5
10
15
20
Relative Abundance (%)
TEMPERATE MIGRANTS
AMRO
BLJA
RSTO
COGR
EAME
GRSP
FISP
RWBL
NOFL
Others
Species
0
5
10
15
20
25
30
Relative Abundance (%)
NEOTROPICAL MIGRANTS
REVI
OVEN
PIWA
WOTH
ACFL
GCFL
SUTA
EAPH
EAWP
BGGN
SCTA
INBU
YBCU
COYE
Others
Species
0
5
10
15
20
Relative Abundance (%)

Figure 4.

habitats. Neotropical migrant species were dominated by the Red-eyed Vireo, Ovenbird, Pine Warbler, Wood Thrush, Acadian Flycatcher, and Great-crested Flycatcher. These are common breeding species throughout coastal Virginia and all are closely associated with forested habitats.

Habitat Patterns

The five general habitat categories considered were not equal in terms of the numbers and types of breeding birds supported (TABLE 3). Forested habitats in general were the most similar in terms of both bird density and species richness. These habitats supported the highest peak densities of breeding birds overall and the greatest number of species. However, both early successional and urban habitats supported species complexes that were unique to them (TABLE 4). For example, compared to other habitats, early successional patches supported the highest densities of temperate migrants. Urban habitats supported the fewest neotropical migrants but did support several species that were uncommon within other habitats (TABLE 4).

The three bird categories examined responded differently to available habitats in terms of both species richness and breeding density (FIGURES 5 and 6). Resident species reached their highest average diversity and abundance within urban patches. In contrast, residents reached their lowest diversity and breeding density within early successional patches. Forested patches supported intermediate numbers of resident birds. As indicated above, temperate migrants reached their highest breeding densities within early successional patches. Forested patches supported the lowest number of both temperate migrant species and individuals. Neotropical migrants exhibited the most dramatic pattern with habitat type in terms of both species richness and breeding density. Compared to both urban and early successional patches, forested habitats supported the highest number of neotropical migrant species and individuals. Within forested

TABLE 3. Mean peak density values for species categories by habitat type. Habitat type includes: ES - early successional, U - Urban, PF - Pine-dominated Forest, MF - Mixed Forest, HF - Hardwood-dominated Forest. Density values reported in birds/10 ha. Parenthetic values indicate number of species. Number of patches sampled by habitat was: ES - 4 patches, U - 4 patches, PF - 28 patches, MF - 8 patches, HF - 8 patches.

Species Category	**ES**	**U**	**PF**	**MF**	**HF**
Resident Species	31.5 (13)	81.2 (18)	75.0 (19)	80.7 (16)	90.9 (19)
Temperate Migrants	60.2 (11)	44.6 (11)	36.7 (11)	25.0 (11)	23.6 (10)
Neotropical Migrants	34.3 (16)	0 (4)	60.1 (25)	74.5 (25)	89.4 (29)
Total Birds	126.0 (40)	125.8 (33)	171.8 (55)	180.2 (52)	203.9 (58)

TABLE 4. Mean density of birds by habitat type. Habitat types include: ES - early successional, U - urban, PF - pine-dominated forest, MF - mixed forest, and HF - hardwood-dominated forest. Numeric values indicate mean densities (birds/10 ha). Asterix indicates species detected within habitat but outside of survey plots. Parenthetic values indicate the number of patches of each habitat where the species was detected. Number of patches sampled by habitat was: ES - 4 patches, U - 4 patches, PF - 28 patches, MF - 8 patches, and HF - 8 patches.

Species	ES	U	PF	MF	HF
Wood Duck				* (1)	* (1)
Green-backed Heron				* (1)	* (1)
Killdeer		1.6 (2)			
Northern Bobwhite	* (2)		* (6)		
Wild Turkey			0.2 (2)		0.8 (2)
Rock Dove		4.8 (2)			
Mourning Dove	2.2 (5)	4.8 (1)	2.7 (1)	1.1 (3)	2.0 (4)
Turkey Vulture			* (2)	* (1)	* (2)
Black Vulture				* (1)	
Cooper's Hawk					* (1)
Red-tailed Hawk			0.3 (2)	1.3 (3)	1.6 (2)
Red-shouldered Hawk					0.4 (1)
Bald Eagle	* (1)		* (1)		
American Kestrel	* (2)	* (1)			
Osprey			0.2 (1)		
Yellow-billed Cuckoo			0.9 (9)	1.6 (6)	1.7 (4)
Belted Kingfisher					* (1)
Hairy Woodpecker				1.7 (4)	1.5 (3)
Downy Woodpecker	0.8 (1)	0.8 (2)	6.0 (24)	6.6 (8)	7.1 (8)
Pileated Woodpecker			1.4 (9)	1.8 (3)	2.1 (5)
Red-headed Woodpecker		1.6 (1)			
Red-bellied Woodpecker	2.4 (1)	* (1)	5.0 (19)	6.2 (8)	2.6 (6)
Northern Flicker		1.6 (3)	2.3 (8)	1.9 (3)	1.6 (3)
Chimney Swift	0.6 (1)				
Ruby-throated Hummingbird	* (1)		0.7 (2)	0.4 (2)	* (1)
Eastern Kingbird	0.6 (1)	* (1)	* (2)		
Great-crested Flycatcher		* (1)	3.4 (19)	4.8 (8)	6.9 (8)
Eastern Phoebe			3.2 (16)	5.0 (5)	3.3 (6)
Eastern Wood-pewee			1.6 (14)	5.6 (8)	6.1 (6)

TABLE 4. --continued--

Species	ES	U	PF	MF	HF
Acadian Flycatcher			3.2 (13)	4.7 (6)	7.3 (6)
Blue Jay	* (1)	4.0 (4)	6.3 (19)	7.4 (8)	7.8 (7)
American Crow	* (1)	* (4)	3.6 (17)	2.4 (4)	1.8 (4)
Fish Crow		* (1)	0.1 (4)	* (1)	0.5 (1)
European Starling	10.3 (1)	36.6 (4)	0.9 (2)		
Brown-headed Cowbird	3.0 (3)	* (2)	3.2 (17)	3.0 (6)	2.1 (6)
Red-winged Blackbird	5.7 (1)				
Eastern Meadowlark	5.7 (3)	0.8 (1)			
Orchard Oriole	2.5 (2)				
Common Grackle	0.8 (1)	15.1 (4)	6.1 (8)	0.7 (2)	1.2 (4)
House Finch		10.3 (4)			
American Goldfinch	5.9 (3)		4.1 (17)	4.1 (4)	6.9 (5)
Grasshopper Sparrow	14.5 (2)				
Chipping Sparrow		0.8 (1)	1.0 (5)	* (1)	
Field Sparrow	7.0 (3)	0.8 (1)	* (1)		
Song Sparrow		15.1 (4)			
Rufous-sided Towhee	4.6 (3)		8.2 (23)	5.5 (8)	3.3 (4)
Northern Cardinal	3.7 (2)	1.6 (2)	11.0 (27)	7.3 (8)	12.5 (7)
Blue Grosbeak	2.5 (2)		* (1)		
Indigo Bunting	6.8 (3)		0.5 (6)	0.4 (1)	1.3 (1)
Scarlet Tanager			1.9 (8)	5.2 (7)	5.5 (6)
Summer Tanager	* (1)		2.0 (18)	4.0 (7)	4.4 (7)
Purple Martin	0.6 (1)		0.2 (1)		
Barn Swallow	* (2)	* (1)			
Northern Rough-winged Swallow	* (2)	* (2)			
Loggerhead Shrike		2.4 (1)			
Red-eyed Vireo			10.9 (24)	12.6 (7)	15.8 (8)
Yellow-throated Vireo			0.1 (3)	0.8 (3)	* (1)
White-eyed Vireo	3.8 (2)		* (7)	0.5 (2)	0.8 (1)
Black-and-white Warbler			* (1)	0.4 (1)	0.4 (2)
Prothonotary Warbler					* (1)
Worm-eating Warbler			0.6 (2)		
Northern Parula				0.4 (1)	

TABLE 4. --continued--

Species	ES	U	PF	MF	HF
Yellow-throated Warbler			0.1 (1)		* (1)
Pine Warbler			10.3 (24)	6.3 (6)	5.4 (7)
Pairie Warbler	4.0 (3)		* (2)	0.4 (2)	
Ovenbird			10.6 (21)	7.0 (7)	8.6 (8)
Louisiana Waterthrush				0.8 (2)	* (1)
Kentucky Warbler				0.8 (4)	1.6 (4)
Common Yellowthroat	6.5 (2)		0.7 (4)	0.8 (3)	1.1 (2)
Yellow-breasted Chat	4.8 (2)				
Hooded Warbler			0.4 (2)	0.4 (2)	0.4 (1)
American Redstart			0.3 (1)		
House Sparrow		8.8 (3)			
Northern Mockingbird		12.7 (4)	0.1 (3)	* (1)	0.5 (1)
Gray Catbird	1.6 (1)		1.5 (8)	1.5 (3)	3.3 (2)
Brown Thrasher	0.8 (1)	0.8 (1)	1.1 (7)	1.3 (3)	0.9 (3)
Carolina Wren	0.8 (1)		7.8 (25)	8.4 (8)	9.6 (8)
House Wren			0.2 (1)	* (1)	
White-breasted Nuthatch		* (1)	3.0 (13)	3.6 (8)	3.8 (6)
Brown-headed Nuthatch			0.2 (2)		0.5 (1)
Tufted Titmouse	* (1)	1.2 (3)	11.8 (26)	19.2 (8)	17.8 (8)
Carolina Chickadee	2.4 (1)	1.6 (2)	13.9 (26)	15.3 (8)	18.4 (8)
Blue-gray Gnatcatcher	* (1)		3.9 (14)	3.2 (6)	6.7 (7)
Wood Thrush			2.7 (14)	6.9 (8)	8.8 (6)
American Robin	21.1 (3)	18.3 (4)	10.9 (22)	6.9 (7)	7.2 (5)
Eastern Bluebird	* (1)	0.8 (1)	0.5 (2)		

FIGURE 5. Average species richness values for species categories and habitat types. Values presented are means $\pm$ 1 S.E. unit for all patches surveyed for each habitat type. See text for the number of patches surveyed for each habitat type.

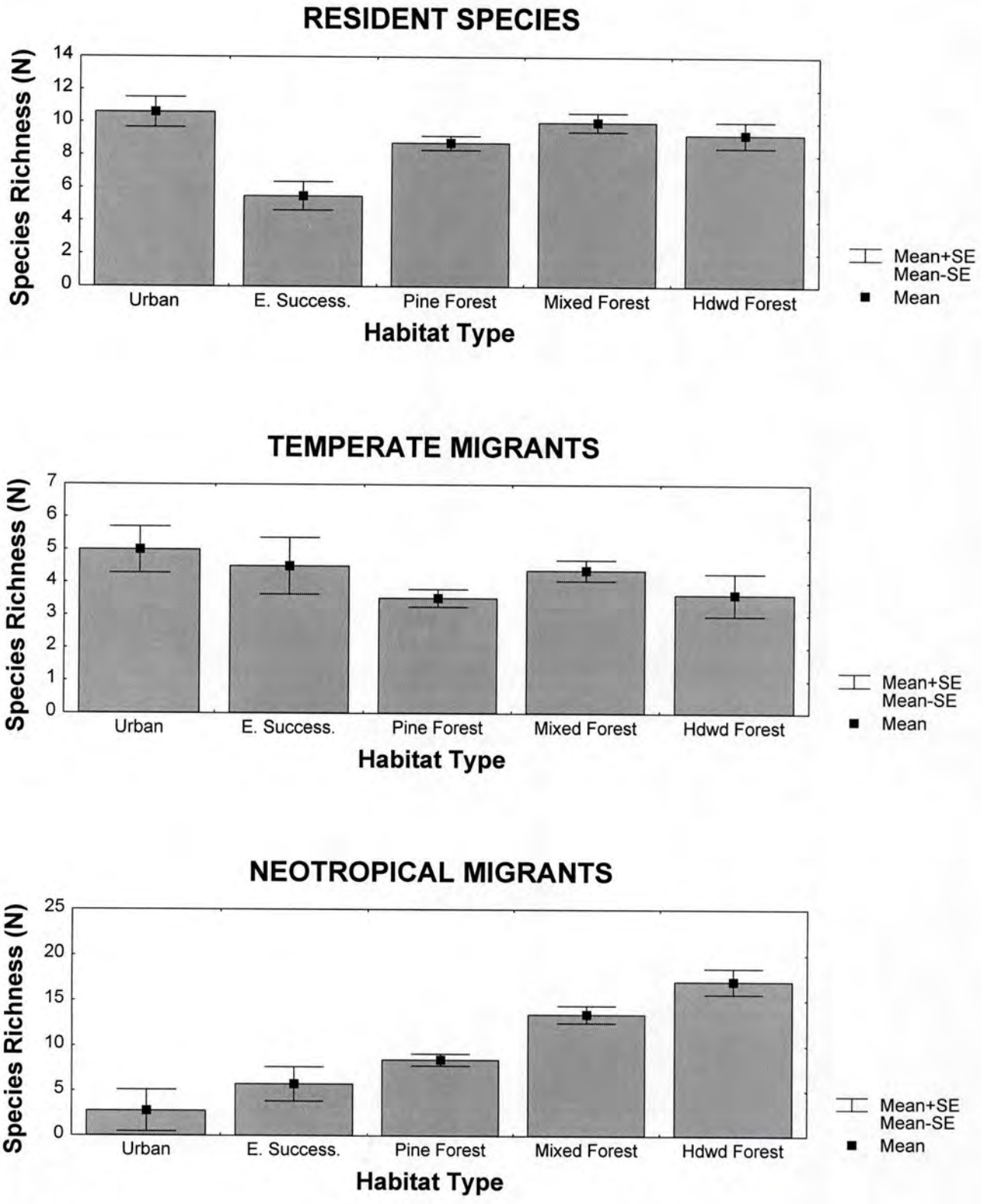
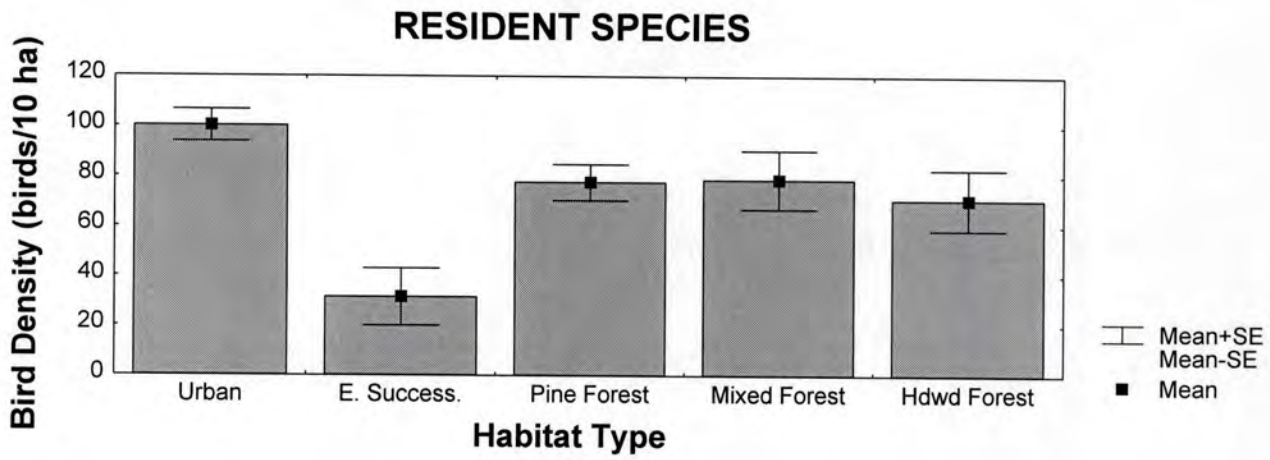
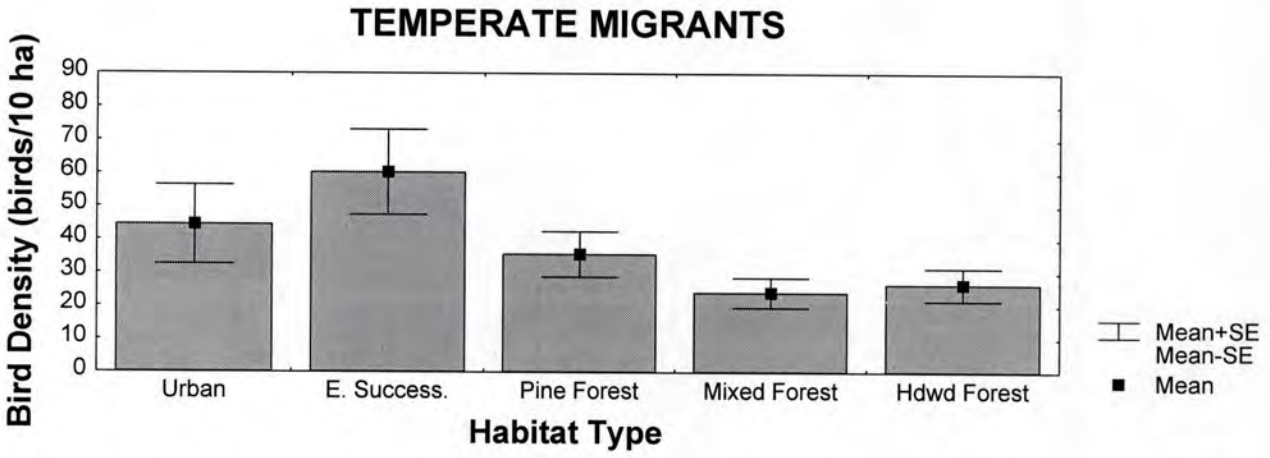

RESIDENT SPECIES
Species Richness (N)
14
12
10
8
6
4
2
0
Urban
E. Success.
Pine Forest
Mixed Forest
Hdwd Forest
Habitat Type
Mean+SE
Mean-SE
Mean
TEMPERATE MIGRANTS
Species Richness (N)
7
6
5
4
3
2
1
0
Urban
E. Success.
Pine Forest
Mixed Forest
Hdwd Forest
Habitat Type
Mean+SE
Mean-SE
Mean
NEOTROPICAL MIGRANTS
Species Richness (N)
25
20
15
10
5
0
Urban
E. Success.
Pine Forest
Mixed Forest
Hdwd Forest
Habitat Type
Mean+SE
Mean-SE
Mean

Figure 5.

FIGURE 6. Average density (birds/10ha) for species categories and habitat types. Values presented are means $\pm$1 S.E. unit for all patches surveyed for each habitat type. See text for the number of patches surveyed for each habitat type.


RESIDENT SPECIES
Bird Density (birds/10 ha)
120
100
80
60
40
20
0
Urban
E. Success.
Pine Forest
Mixed Forest
Hdwd Forest
Habitat Type
Mean+SE
Mean-SE
Mean


TEMPERATE MIGRANTS
Bird Density (birds/10 ha)
90
80
70
60
50
40
30
20
10
0
Urban
E. Success.
Pine Forest
Mixed Forest
Hdwd Forest
Habitat Type
Mean+SE
Mean-SE
Mean

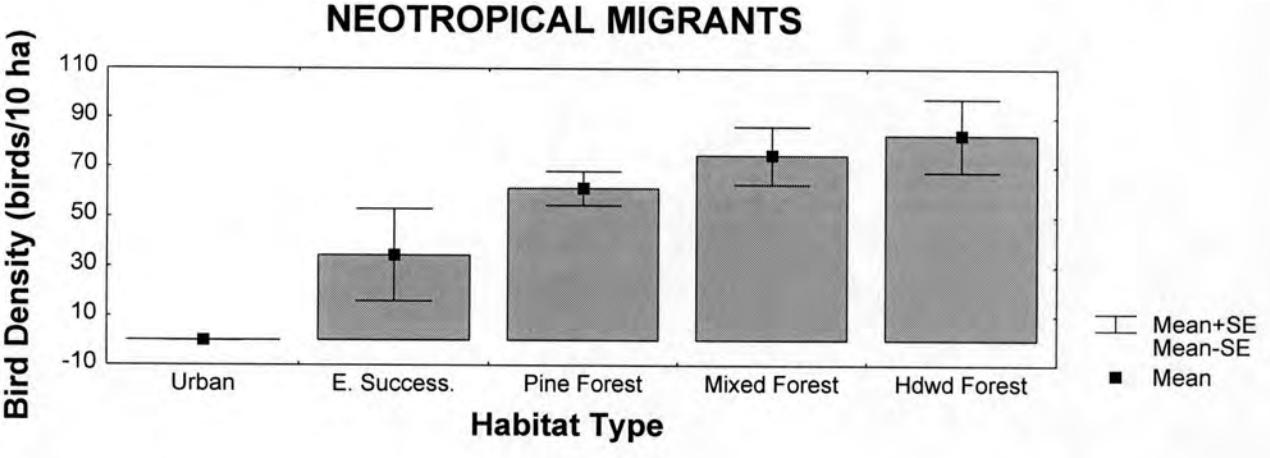

NEOTROPICAL MIGRANTS
Bird Density (birds/10 ha)
110
90
70
50
30
10
-10
Urban
E. Success.
Pine Forest
Mixed Forest
Hdwd Forest
Habitat Type
Mean+SE
Mean-SE
Mean

Figure 6.

habitats, species richness and breeding density was positively influenced by the amount of hardwood within the patch. Consequently, hardwood-dominated forests supported the highest number of neotropical migrant species and individuals.

Urban - Compared to all other habitats examined, urban patches supported the lowest number of both species and individuals. The low number of birds supported overall was due entirely to the lack of neotropical migrants within this habitat type. Urban patches supported considerable numbers of both residents and temperate migrants. The community was composed primarily of species associated with human development such as the European Starling, House Finch, Rock Dove, and Northern Mockingbird, as well as, species that forage within open lawns such as the American robin, Killdeer, and Common Grackle. Six species were exclusive to this habitat type and five additional species reached their highest density here (TABLE 4).

Early Successional - Compared to all other habitat types, early successional patches supported the highest density of temperate migrants and the lowest density of resident species. Temperate migrants were comparatively high largely due to the fact that many grassland species such as sparrows and meadowlarks happen to be temperate migrants. The community was composed primarily of grassland obligate species such as the Grasshopper Sparrow, Eastern Meadowlark, Eastern Kingbird, American Kestrel, as well as, a number of shrub-dependent species such as the White-eyed Vireo, Prairie Warbler, Common Yellowthroat, Blue Grosbeak, and Yellow-breasted Chat. Four species were found exclusively in this habitat and ten additional species reached their highest density here (TABLE 4).

Pine-dominated Forest - Of the three forest types considered, pine-dominated patches supported the lowest density of birds overall. These patches supported fewer species within all

three species categories than the other forest types. Pine-dominated patches supported similar densities of resident species, lower densities of neotropical migrants, and slightly higher densities of temperate migrants. The higher density of temperate migrants was almost entirely due to the high number of American Robins and Common Grackles. Three species were found exclusively within these patches and an additional eight species reached their highest density here (TABLE 4).

Mixed Forest - Of the three forest types considered, mixed forests were intermediate in the overall number of birds supported and compared to all habitats were second only to hardwood-dominated forests. These patches were generally comparable to the other forest patches in the number of resident species and temperate migrants supported and intermediate in the number of neotropical migrants supported. Only two species were detected exclusively in this habitat type, however, an additional six species reached their highest densities here (TABLE 4).

Hardwood-dominated Forest - Hardwood-dominated forest patches supported the highest overall density of birds and the highest number of species. This pattern is primarily due to the larger number of neotropical migrants supported. Although there were only two species of neotropical migrants that were found exclusively within these patches, fourteen reached their highest densities within this habitat type. Red-eyed Vireos, Great-crested Flycatchers, Acadian Flycatchers, and Wood Thrushes in particular seemed to prefer hardwood forests.

Distribution of Neotropical Migrants

Although neotropical migrants were distributed over the entire installation, breeding density varied considerably between habitats and geographic areas (FIGURE 7a and 7b).

FIGURE 7. Map of Main Post a) and Range Training Area b) the density of neotropical migrants supported by habitat patches surveyed. Patch numbers correspond to TABLE 1 and TABLE 2. Both maps are modified from Mallette 1997.

Map of Neotropical Migrant Densities
(Fort Lee Main Post)

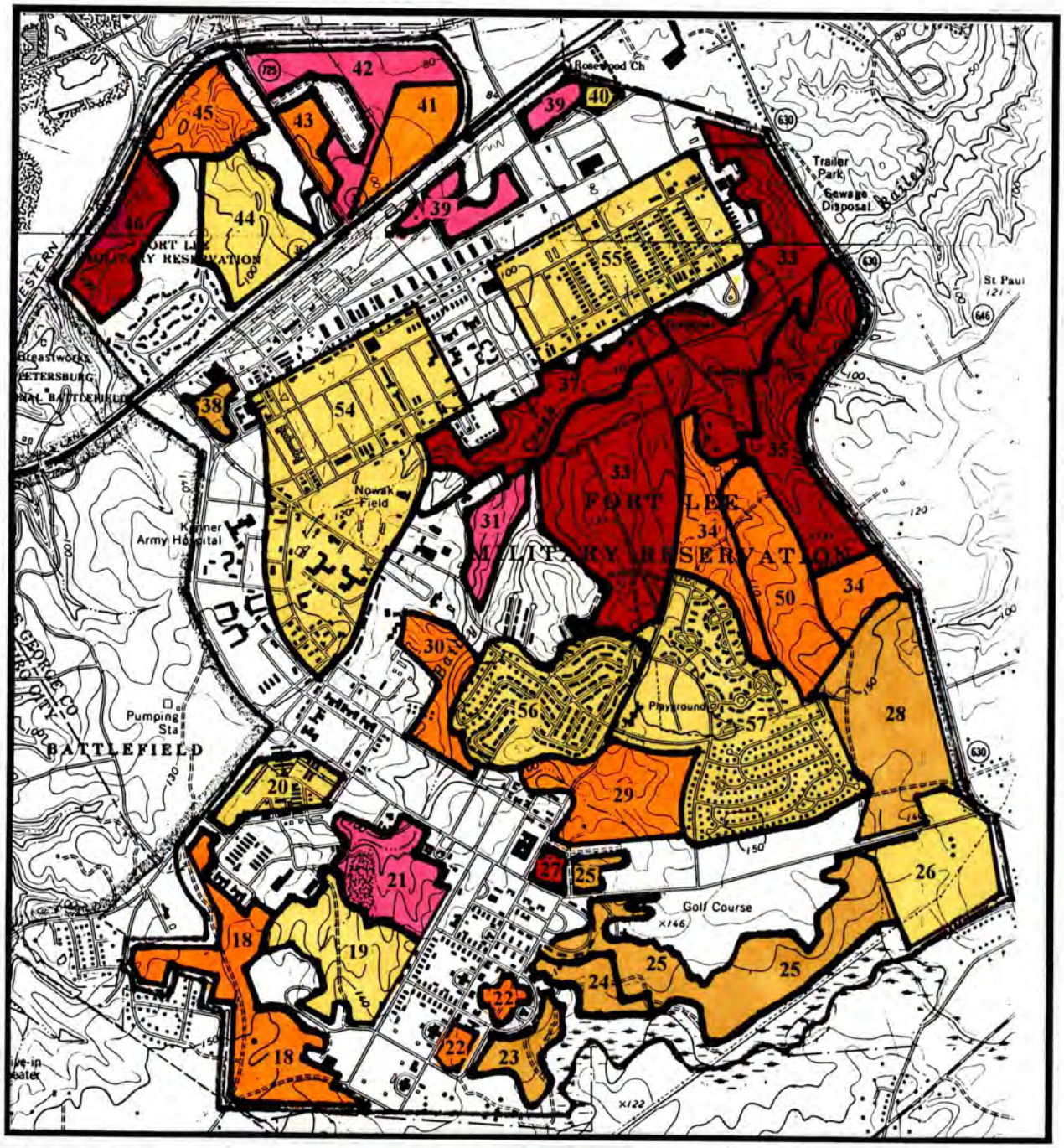


Figure 7A

Map of Neotropical Migrant Densities
(Fort Lee Range Training Area)

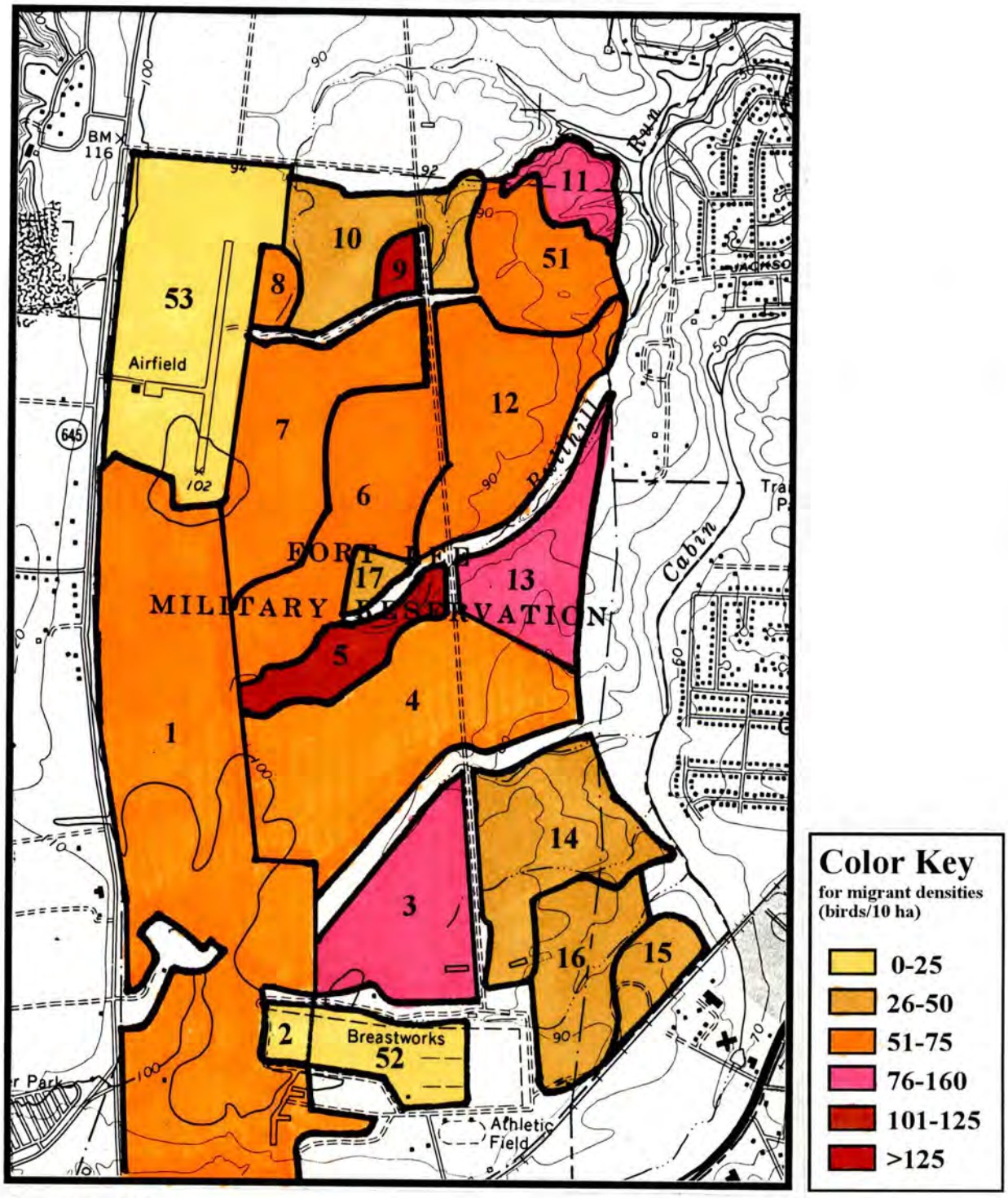


Figure 7B

Densities were lowest within grasslands, urban areas, and young pine-dominated forests. Older pine-dominated forests supported moderate densities of neotropical migrants as may be seen within the vast pine areas of the Range Training Area. Lands supporting high densities of neotropical migrants were typically mixed forests and hard-wood dominated forests associated with drainages. The influence of streams on migrant density is evident within the Main Post where high-density areas are clustered around the headwaters of Baileys Creek. This association is also evident in the high density recorded in patch 46 and in the elevated densities around Bullhill Run within the Range Training Area.

DISCUSSION

The results of this study indicate a diverse breeding bird community distributed widely within the Fort Lee Army installation. The species and their relative abundances are generally consistent with those observed elsewhere within coastal Virginia (Watts pers. obs.). At the patch level, habitat type had a considerable influence on the diversity and number of birds supported. Forested patches supported more birds overall than either early successional or urban patches. This pattern was particularly evident for neotropical migrants. In general, systematic changes in bird communities are common across gradients of habitat structure (e.g. Johnston and Odum 1956, Karr 1971). It is generally believed that structural complexity is related to resource diversity such that highly structured habitats provide more opportunity for species packing compared to structurally simple habitats. Both vertical and horizontal complexity are generally greater (due to vertical layering and horizontal patchiness of the understory) within forested habitats compared to early successional habitats. Both of these factors have been shown to

contribute to the diversity of breeding bird communities (e.g. MacArthur and MacArthur 1961, Roth 1976, Karr 1971).

The results of this study provide insights into the habitat requirements of birds supported by the Fort Lee Army installation that are important to the development of appropriate management guidelines. Because bird communities and their requirements differ at the habitat level, management plans should be developed that are habitat-specific.

Early successional habitats within the installation include intensively managed grasslands and shrublands. Of these two, grasslands are the most important habitats on a regional scale. The two patches of managed grasslands considered here (i.e. McLaney Drop Zone and the M60 range) supported significant populations of grassland-obligate species such as the Grasshopper Sparrow and the Eastern Meadowlark. Both of these species have experienced dramatic population declines in northeastern North America in recent decades due to a transition to more intensive farming practices and the loss of idle grassland habitats via secondary succession (Vickery 1992). Currently, the mid-Atlantic region appears to be a stronghold for these two species (Watts et al. 1997). However, because these species are area-sensitive, continued maintenance of mid-Atlantic populations critically depends on the management of remaining large grassland patches. The MacLaney Drop Zone and adjacent grasslands have conservation significance on a regional scale for the grassland bird community. A management strategy should be developed for this patch that considers 1) the type and frequency of maintenance activities, and 2) the seasonal timing of maintenance activities.

Shrublands are currently relatively rare within the Fort Lee Army installation. The two patches considered here were patch 50 (a recent clearcut) and patch 51 (an idle grassland

proceeding through secondary succession). Throughout the mid-Atlantic coastal plain, shrublands are fairly common due to the widespread use of clearcutting as a harvesting technique on silvicultural lands. Shrublands arising from secondary succession of idle grasslands are much less common. Although shrublands support a diverse bird community with several unique species of neotropical migrants, these species are not generally area-sensitive (Watts et al. 1997). The patches located on Fort Lee Army installation are not significant on a regional scale. Clearcuts are ephemeral habitats that are generally not intended to be maintained in an early successional stage. Patch 51 could be maintained as a shrubland through the use of a staggered maintenance program (Watts et al. 1997). A management strategy should be developed for this patch that considers 1) the type and frequency of maintenance, 2) the spatial configuration of maintenance, and 3) the seasonal timing of maintenance activities.

Urban habitats within the Fort Lee Army installation include training areas, office complexes, storage facilities, recreational areas and residential neighborhoods. This habitat type currently occupies a large and increasing portion of the main post landscape. Habitats that are functionally equivalent to those found on Fort Lee are increasingly abundant and widely distributed throughout the region. The bird community observed within urban patches was dominated by resident species and temperate migrants. Dominant species included several such as the European Starling, Rock Dove, House Finch, and House Sparrow that are not native. Urban landscapes represent the primary breeding areas for these species. In comparison to the other habitat types examined, urban patches supported very low numbers of neotropical migrants. The absence of this bird community reflects the overall vegetative structure within these patches. Urban patches are highly dissected, have low densities of understory vegetation that is

primarily composed of exotic plants, and extensive coverage of sod-forming grasses. These patches have no significance on a regional scale. Development of a management plan that considers the use of native plants for foundation plantings, interstitial set asides with natural vegetative structure and limited sod-forming grasses may help to attract breeding neotropical migrants.

Forests cover large blocks of land within the Fort Lee Army installation and are the most abundant of the habitats considered here. Compared to the other two habitats, forests were observed to support the greatest density of birds. This combined with their extensive coverage, suggests that forested lands support the bulk of the bird community found on the installation. In contrast to the other bird groups, neotropical migrants appeared to be directly influenced by forest composition. Forest patches that were dominated by hardwoods supported more species and greater densities of neotropical migrants. Neotropical migrants appear to be particularly dense in forest patches with high topographic relief such as those areas forming the headwaters of Baileys Creek in the east-central portion of the main post. These patterns should be considered during the development of a forest management plan.

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APPENDIX 1. List of breeding species detected during the study period and their migration status. See methods for description of migration categories.

Common Name	Species Name	Resident	Temperate	Neotropical
Wood Duck	*Aix sponsa*	X		
Green-backed Heron	*Butorides striatus*			X
Killdeer	*Charadrius vociferus*		X	
Northern Bobwhite	*Colinus virginianus*	X		
Wild Turkey	*Meleagris gallopavo*	X		
Rock Dove	*Columba livia*	X		
Mourning Dove	*Zenaida macroura*	X		
Turkey Vulture	*Cathartes aura*		X	
Black Vulture	*Coragyps atratus*		X	
Cooper's Hawk	*Accipiter cooperi*			X
Red-tailed Hawk	*Buteo jamaicensis*		X	
Red-shouldered Hawk	*Buteo lineatus*	X		
Bald Eagle	*Haliaeetus leucocephalis*	X		
American Kestrel	*Falco sparverius*		X	
Osprey	*Pandion Haliaetus*			X
Yellow-billed Cuckoo	*Coccyzus americanus*			X
Belted Kingfisher	*Megaceryle alcyon*		X	
Hairy Woodpecker	*Picoides villosus*	X		
Downy Woodpecker	*Picoides pubescens*	X		
Pileated Woodpecker	*Dryocopus pileatus*	X		
Red-headed Woodpecker	*Melanerpes erythrocephalus*	X		
Red-bellied Woodpecker	*Melanerpes carolinus*	X		
Northern Flicker	*Colaptes auratus*		X	
Chimney Swift	*Chaetura pelagica*			X
Ruby-throated Hummingbird	*Archilocus colubris*			X
Eastern Kingbird	*Tyrannus tyrannus*			X
Great-crested Flycatcher	*Myiarchus crinitus*			X
Eastern Phoebe	*Sayornis phoebe*		X	
Eastern Wood-pewee	*Contopus virens*			X
Acadian Flycatcher	*Empidonax virescens*			X
Blue Jay	*Cyanocitta cristata*		X	
American Crow	*Corvus brachyrhynchos*	X		
Fish Crow	*Corvus ossifragus*	X		
European Starling	*Sturnus vulgaris*	X		
Brown-headed Cowbird	*Molothrus ater*	X		
Red-winged Blackbird	*Agelaius phoeniceus*		X	
Eastern Meadowlark	*Sternella magna*		X	
Orchard Oriole	*Icterus spurius*			X
Common Grackle	*Quiscalus quiscula*		X	

APPENDIX 1. --continued--

Common Name	Species Name	Resident	Temperate	Neotropical
House Finch	*Carpodacus mexicanus*	X		
American Goldfinch	*Carduelis tristis*	X		
Grasshopper Sparrow	*Ammodramus savannarum*		X	
Chipping Sparrow	*Spizella passerina*		X	
Field Sparrow	*Spizella pusilla*		X	
Song Sparrow	*Melospiza melodia*	X		
Rufous-sided Towhee	*Pipilo erythrophthalmus*		X	
Northern Cardinal	*Cardinalis cardinalis*	X		
Blue Grosbeak	*Guiraca caerulea*			X
Indigo Bunting	*Passerina cyanea*			X
Scarlet Tanager	*Piranga olivacea*			X
Summer Tanager	*Piranga rubra*			X
Purple Martin	*Progne subis*			X
Barn Swallow	*Hirundo rusticus*			X
Northern Rough-winged Swallow	*Stelgidopteryx ruficollis*			X
Loggerhead Shrike	*Lanius ludovicianus*	X		
Red-eyed Vireo	*Vireo olivaceous*			X
Yellow-throated Vireo	*Vireo flavifrons*			X
White-eyed Vireo	*Vireo griseus*			X
Black-and-white Warbler	*Mniotilta varia*			X
Prothonotary Warbler	*Protonotaria citrea*			X
Worm-eating Warbler	*Helmitheros vermivorus*			X
Yellow Warbler	*Dendroica petechia*			X
Yellow-throated Warbler	*Dendroica cominica*			X
Pine Warbler	*Dendroica pinus*			X
Pairie Warbler	*Dendroica discolor*			X
Ovenbird	*Seiurus aurocapillus*			X
Louisiana Waterthrush	*Seiurus motacilla*			X
Kentucky Warbler	*Oporornis formosus*			X
Common Yellowthroat	*Geothlypis trichas*			X
Yellow-breasted Chat	*Icteria virens*			X
Hooded Warbler	*Wilsonia citrina*			X
American Redstart	*Setophaga ruticilla*			X
House Sparrow	*Passer domesticus*	X		
Northern Mockingbird	*Mimus polyglottis*	X		
Gray Catbird	*Dumetella carolinensis*			X
Brown Thrasher	*Toxostoma rufum*		X	
Carolina Wren	*Thryothorus ludovicianus*	X		
House Wren	*Troglodytes aedon*			X
White-breasted Nuthatch	*Sitta carolinensis*	X		

APPENDIX 1. --continued--

Common Name	Species Name	Resident	Temperate	Neotropical
Brown-headed Nuthatch	*Sitta pusilla*	X		
Tufted Titmouse	*Parus bicolor*	X		
Carolina Chickadee	*parus carolinensis*	X		
Blue-gray Gnatcatcher	*Poliopltila caerulea*			X
Wood Thrush	*Hylocichla mustelina*			X
American Robin	*Turdus migratorius*		X	
Eastern Bluebird	*Sialia sialis*		X	